REVIEW PAPER

Seasonal impact on physico-chemical parameters of fresh water resources- A review

M. Manonmani[1], TA. Sathya[2], R. Anburaj[3], K. Gokilavani[4], PS. Geethanjali[4], S. Viswanathan*[5]

[1]*Post Graduate and Research Center, Department of Microbiology (Government Aided), Sri Paramakalyani College, Alwarkurichi, Tamilnadu, India*

[2]*PG & Research Department of Microbiology, Vivekanandha College of Arts and Sciences (Autonomous) for Women, Elayampalayam, Tiruchencode, Tamilnadu, India*

[3]*PG and Research Department of Biotechnology, Microbiology and Bioinformatics, National College (Autonomous), Tiruchirappalli,Tamil Nadu, India*

[4]*Vivekanandha College of Arts and Science for Women (Autonomous) Elayampalayam, Tiruchencode, Tamilnadu, India*

[5]*Post Graduate & Research Centre of Microbiology, Sri Paramakalyani College, Alwarkurichi, Tamilnadu, India*

Abstract

Water being elixir of life and have unique properties like surface tension, cohesion and ability to dissolve a wide range of substances, contribute to its importance in supporting life on Earth. Freshwater ecosystem provides water supply for versatile purposes such as drinking, sanitation, irrigation and various economic sectors. The Freshwater ecosystem is grouped into several categories i.e., rivers, lakes, waterfalls, wetlands, streams, reservoirs and ponds. Even though we have these abundant sources of water bodies the real challenge lies on the accessibility to Clean, safe and adequate freshwater in the aquatic ecosystem. Among all these aforesaid water bodies rivers, lake and wetlands are considering as vital for human beings for multiple purposes and it need to be conserved and protected. In order to control the fresh water from getting polluted we need to gather reliable information's on water quality for the effective supervision of water resources. The excellence of Fresh water can simply affect by the Waste disposal, anthropogenic-induced changes and Seasonal Variations, which lead various negative features to the living welfare. This constant disintegration of fresh water, its needs to be protected from further deterioration by regularly monitoring and evaluating the water and its qualities. On this front, we need to identify perpetual water using different physicochemical parameters and biological properties and regulate the aptness of water. This paper thrives to get knowledge about the influence of seasonal changes on physico-chemical parameters and Microbiological parameters on fresh water.

***Corresponding Author:** S Viswanathan ✉ drsvmicro@gmail.com

Introduction

Water is a solitary unique and key resource which is found in around about 75% of the earth's crust. Quality water shall steer us to a healthy environment for all the living things and natural resources in the world (Kumar *et al.*, 2017). In the entire world water resources and their quality are playing a paramount role in our day to day life. Water being an elixir and inevitable product of human life and habitats it has now become an endangered component due to proliferating contamination.

Water bodies contain diverse range of floating, dissolved, suspended and biological as well as pathological impurities but, nowadays it has become more vulnerable to contamination due to human activities and natural disasters. So before using the water, apart from checking the physical appearance such as color, taste, temperature, pH, turbidity, etc., while chemical tests also should be performed for identifying its Biological oxygen demand, Chemical oxygen demand, Dissolved oxygen, alkalinity, hardness and other characters (Bhateria *et al.*, 2016) .Mainly water resources can be categorized into three types (Fresh water, Surface water and Ground water). Among these three, the fresh water resources are mainly used for all biotic and a biotic factor in our living system. Freshwater shall be any naturally occurring liquid or frozen water which includes river, lake, pond, waterfalls (Madilonga *et al.*, 2021).

Freshwater Biodiversity is also under severe threat due to seasonal variations and day today activities of human (Albert *et al.*, 2020). Due to these seasonal variations, every year the quality of water can gradually be decreased across the world and also its leads both optimistic and harmful impacts on the superiority of water (Beck *et al.*, 2012). Due to these seasonal impacts all physical and chemical parameters of water can be varied and it may lead to precarious impacts to the living systems. Considering the fact that we need to ensure clean and safe environment we need to monitor and evaluate the quality of water in many organized methodologies. The following (Fig. 1) shows what are the common factors that can affect the fresh water quality (Dey *et al.*, 2021).
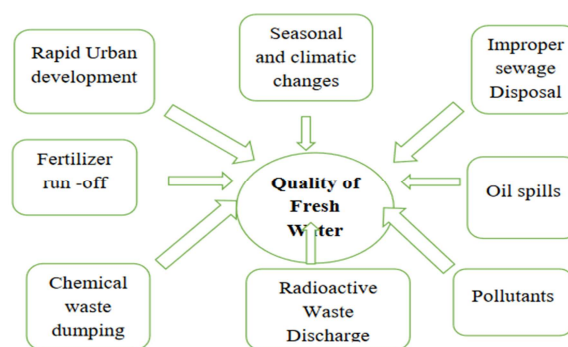
Fig. 1. Some important causes of water quality decrement

In many developing countries research works are to be conducted and significant contribute to examine the excellence of water through the physic-chemical parameters of water and study their various biological aspects by adopting advanced techniques (Cuffney *et al.*, 2014). By analyzing the various water quality parameters, we shall be able to understand whether it's harmful to agricultural and industrial purposes, water portability, the pollutants found in aquatic base, understanding the life style presence and distortion of aquatic flora & fauna in the aquatic environment (Li *et al.*, 2010).

A river is a natural flowing watercourse, which is considered as one of the most important freshwater ecosystem (Tabari *et al.*, 2010).Seasonal changes in rivers will extremely alter the different chemical, biological, and physical properties of water and as a result it will affect our healthy natural ecosystem and ecological process (Iqbal *et al.*, 2019). Thus, monitoring a specific issue in river and fresh water quality lies in the difficulty related to the analysis and conserve their resources become on challenges (Shil *et al.*, 2019).

The main purpose of our studies was to critically review and acclaim the physical, chemical, and biological aspects of aquatic quality through standard parameters and how they varied with seasonal changes by using various research works and publications. Based on that, we can easily find out the current status of fresh water and the compatible parameters for analyzing each fresh water sources.

Studies on seasonal changes on fresh water

Rainfall is the chief cause of fresh water, which fills up freshwater habitats such as Ponds, lakes, rivers, and streams. In India we have a large amount of fresh water resources and among them rivers play a major part in our country (Fig. 2).

Fig. 2. Fresh water sources in INDIA (https://www.mapsofindia.com/water/)
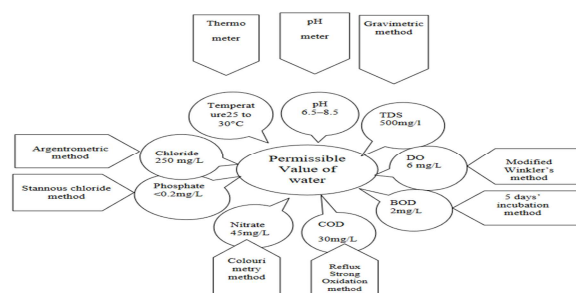
Fig. 3. Permissible value and method of some physico-chemical parameter

In India we have around 60 river basins out of which we have 12 major river basins and 48 medium river basins (lakes, ponds, wetland's etc.,). Out of these major and medium river basins we are selecting ten fresh water research works for our study and analyze the seasonal impact on physico–chemical and biological parameter of fresh water sources. The water testing process can be made on seasonal basis against a set of certain pre-requisites with which the biggest threat of diminishing and deterioration of fresh water resources can be restored (Elayaraj *et al.*, 2015).

Changes on physico-chemical parameter

The daily water demands for domestic, agricultural, and industrial activities are fulfilled by the natural fresh water bodies (e.g., rivers, lakes, wetlands, ponds, etc. (Eliku *et al.*, 2018). The causes of seasonal changes in fresh water are interlocked with the effects on biodiversity, aquaculture, coastal areas, and people (Dey *et al.*, 2021). It is an adverse and highly impact able problem in most of the developing countries including India (Miller *et al.*, 2017).

The characteristics of fresh water change seasonally. Seasons have three different group such as (Maansi *et al.*, 2022). Such as Pre-monsoon (January -April), Monsoon (May-September) and Post-monsoon (October-December). Such variations have a severe impact on the worsening of the quality of fresh water, which in turn brings about larger variations in the physicochemical and microbiological parameters of fresh water (Toraskar *et al.*, 2022).

In this review, we focused on seasonal changes (Pre-monsoon and Post-monsoon) of various fresh water resources like lake, pond, wet land and river which was located in and around India and also reviewed their impact on physico –chemical parameter of fresh water. Table 1 shows the various physico-chemical parameters (pH, Temperature, electrical conductivity, TDS, DO, Phosphate then Nitrate) of various fresh water resources.

The following (Fig. 3) shows some important permissible level of physico chemical parameters of water quality (Sharma *et al.*, 2021). As per the standard values of BIS (BIS *et al.*, 2012), and CPCB (CPCB 2008), by using standard methodsAPHA, AWWA, WEF (APHA, AWWA, WEF 1998).

Changes on microbiological parameter

Water resource is an important requirement for microbial growth (Babic *et al.*, 2020). Fresh water must be sufficiently biostable and should be free from microbial impacts so as to aid the growth of living things in aquatic environs. The permissible value of microbes in water is 100 -500 CFU and these parameters may vary due to seasonal changes. These seasonal changes may lead to various health issues and illness to the humans and aquatic life forms (Schurer *et al.*, 2021).Bacteriological analysis of water to indicate the nature of pollution in water so that it is considered important(Sharma *et al.*, 2013).

Table 1. Impact of seasonal changes on physico–chemical parameters in fresh water

SL	Fresh water Sources	Season	pH	Tem. (°C)	Electrical conductivity (μS/cm)	TDS (mg/L)	DO (mg/L)	Phosphate (mg/L)	Nitrate (mg/L)	Reference
1.	Varuna Lake, India	Pre –monsoon	8.18	30.73	273.67	142.67	5.28	<0.1	0.59	Abhilash et al., 2022
		Post monsoon	8.98	26.92	250.67	139.50	5.27	<0.1	1.40	
2.	lakes of Chota Nagpur, India.	Pre –monsoon	8.04	17.57	-	-	5.17	0.16	3.95	Lal et al., 2022
		Post monsoon	7.32	18.33	-	-	4.27	0.19	2.98	
3.	Lake Sukhna, Chandigarh, India	Pre –monsoon	8.5	21.0	195.23	190.50	2.78	0.02	2.00	Jindal et al., 2022
		Post monsoon	8.3	23.0	189.58	150.23	3.56	0.03	1.01	
4.	River Ganga, India.	Pre –monsoon	6.5	30	700	-	3.0	7.5	14.5	Kar et al., 2022
		Post monsoon	7.0	32	550	-	3.5	6	9	
5.	River Cauvery, India	Pre –monsoon	6.5 -8.5	-	Within the permissible value	690.00	6.0	0.03	Within the standards	Sharma et al., 2021
		Post monsoon	>8.5	-	Within the permissible value	220.00	6.0	0.14	Within the standards	
6.	Wetlands of Punjab, India.	Pre –monsoon	7.7	23.5	196.28	200.00	4.72	0.27	0.3	Singh et al., 2022
		Post monsoon	8.4	20.82	231.56	478.50	8.12	0.3	0.2	
7.	tropical wetland, Sundarbans, India	Pre –monsoon	7.72	32.1	387.00	170.00	5.32	0.39	0.014	Gogoi et al., 2019
		Post monsoon	7.37	25.1	629.75	206.00	5.80	0.33	0.009	
8.	aquaculture pond, Dhanbad, India.	Pre –monsoon	6.91	-	610.8	317.00	3.09	0.8	8.06	Pall et al., 2018
		Post monsoon	7.69	-	598.4	298.00	4.06	0.6	7.10	
9.	Doyang River, Nagaland, India.	Pre –monsoon	8.09	-	188.67	93.95	10.56	-	0.65	Sing et al., 2022.
		Post monsoon	6.93	-	155.05	79.17	9.03	-	0.72	
10.	Ganga River system, Uttarakhand, India	Pre –monsoon	-	16.40	138.15	269.22	8.89	0.06	-	Matta et al., 2020
		Post monsoon	-	16.03	131.15	283.04	9.18	0.08	-	

(Note: DO- Dissolved oxygen, TDS- Total Dissolved Solids, DO- Dissolved Oxygen)

Table 2. Impact of pH on fresh water

SL	pH parameter	Causes	Reference
1.	More than 12	hair fibers to swell	
2.	More than 11	Eye irritations, skin, and mucous membranes	(Gupta et al., 2017).
3.	More than 8	Salty water	
4.	Above 4 to 5	Affect aquatic life	
5.	Below 4	Redness, irritation to eyes	(Sudarshan et al., 2019)
6.	Below 2.5	Epithelium get damaged irreversibly	

The potability of microbiologically polluted water, may lead to Diarrhoeal diseases and influence about 2.2 million deaths and one billion illnesses per year (WHO, 2011; Kapembo et al., 2016). The microbiological analysis of the water sample shows the presence of coliforms in it. Presence of Fecal Coliforms and total coliforms indicates that the water might have got contaminated with human sewage, animal droppings and organic loads (Ghildyal et al., 2019). These contaminated water bodies have huge amount of microorganisms in it such as *Salmonella* sp., *Shigella* sp., *E. coli, Vibrio cholera, Pseudomonas sp, Aeromonas hydrophilia, Enterobacter cloacae* and *Legionella* are observed to be maximum in water sample and their ranges can varied seasonally (Dhanalakshmi et al., 2018).

Impact on physical-chemical parameter on water quality
Examination of the physicochemical quality of water parameters plays a pivotal role in assessing the quality of water and restoring water quality in the environment (Whitehead et al., 2018; Islam et al., 2018). When industrial waste, domestic waste, and agricultural drainage waste are diversified with the water, they could be easily polluted (Barakat et al., 2016). In general, some of the mentioned parameters should be monitored for checking the polluting nature

of fresh water or river water, including water temperature, pH, dissolved and suspended solids, turbidity, dissolved oxygen, compounds of phosphorus and nitrogen, biochemical oxygen demand, and chemical oxygen demand (Gupta *et al.*, 2017).

pH

pH is stand as negative logarithm of hydrogen ion concentration in water (pH = -log (H+)). The Permissible pH level of water lies within the range 7–8.5 (USEPA, 1986). A decreased carbon dioxide concentration will, in turn, raise the pH level, whereas an increase in carbon dioxide concentration will cause the pH level to drop. Changes in pH affect the most chemical and biological processes in water. The anthropogenic human activities also change the water sources to be more acidic often than basic (Zaghloul *et al.*, 2019). The following (Table 2) shows the Impact of pH on freshwater.

Monitoring the level of pH in water is used to check the corrosivity of water. The lower pH level will indicate the highest level of corrosion. In addition, pH levels can affect the degree of corrosion of metals as well as disinfection efficiency; they may also have an indirect effect on the health of human beings and habitats (Chabukdhara *et al.*, 2012).

Temperature

Presence of temperature in aquatic eco systems normally fluctuates between day and night and varies from season to season. The measurement of temperature should be monitor periodically for all aquatic based research work. The Permissible temperature level of water 25 to 30°C (Dheenan *et al.*, 2014).With the help of this parameter, we can easily identify the various natures of water bodies. There are various other parameters like alkalinity, salinity, electrical conductivity, BOD and COD are having direct impact based on the water temperature. In aquatic system the flora and fauna can also be easily affected by the temperature (Zaghloul *et al.*, 2019). The sequel of variation in temperature may affect the aquatic plant photosynthesis process by creating

lower oxygen in it and pollutants may become more toxic at high temperature.

Turbidity

The permissible turbidity level of water is 1.0 NTU. The quality of water and freshwater habitats get affected by the increase in turbidity in water. The high turbidity of water sources can become a harbor for microbial pathogens like bacteria, algae, etc., (Hoellein *et al.*, 2014).

Electrical conductivity

Conductivity used to measure the presence of inorganic materials in water, and when these inorganic minerals are dissolved in water in high amounts, it also indicates the presence of total dissolved solids in the water. It is considered essential physical pollution indicators and also measures the quality of aquatic biota in water resources (Manjula *et al.*, 2019).

TDS and TSS

The existence of organic matter and inorganic salt will represent the presence of TDS and TSS in water. Permissible TDS level in water is 500 mg/L.Both TDS and TSS are used to evaluate the amount of biologically inert organic matter (lignin, etc.,) in water. Presence of dissolved salt shall change the entire aquatic life which in turn leads to animal skin dehydration. The higher levels of total suspended solids will automatically increase the water temperature and decreases the level of oxygen which creates an unfavorable environment for aquatic life (Prabha *et al.*, 2020).

Biological Oxygen Demand (BOD)

In aquatic ecosystem under aerobic condition the microorganism decompose the organic matter for their survival. The presence oxygen level is direct proportional to the amount of microorganism present in it. BOD level in water reflects the quantity of dissolved oxygen in all water resources. So it is considered as one of the most significant pollutant indicator in water. The Permissible BOD level of

water is 2.0 mg/L. The increased level of BOD indicates the occurrence of untreated effluents from industrial and domestic users. This effluent water contains huge amount of organic pollutants and releases toxic element in water. These organic pollutants present in the effluents will consume the dissolved oxygen and detoriates the aquatic environment oxygen level. Hence, presence of lesser oxygen level in water will lead to death of fish and other aquatics biotas which indicate the poor quality of river (Bi *et al.*, 2021).

Chemical Oxygen Demand (COD)

COD is a measure of the amount of oxygen required to oxidize organic and inorganic matter in water. It's a critical parameter in evaluating water quality, particularly in wastewater treatment and environmental monitoring. The permissible COD level in water is 30.0 mg/L. Untreated waste water effluents contain large amount of organic compounds like NO3, Fe salts, and sulfide. These untreated waste water effluents will contaminate the fresh water ecosystem once it conjoins. The measurement of COD in water will help us to determine the toxicity level and presence of organic matter in water. High levels of COD in water, always gives a negative environmental and regulatory consequences to the water (Jeff *et al.*, 2015)

Phosphate

Entry of phosphorous in aquatic system is occurred by anthropogenic activity of human and natural disasters, because human being and nature possess lot of phosphorous sources. The Permissible phosphorous level of water is <0.2 mg/L. The discharge of Phosphorous loads contained in waters will increase the higher growth rate of algae blooms, macrophysics and this accelerated plant growth result in reduced water quality in the form of eutrophication in water. Increased phosphorous lead the low DO (dissolved oxygen), change the pH level in water and it is dangerous to the entire living biota and affects the whole food web of aquatic life (Spellman *et al.*, 2014; Water, U.N., 2011).

Nitrate

During organic matter degradation and the use of chemical fertilizers, nitrate is released. Nitrate is one of the essential nutrients to plants. The Permissible nitrate level of water is 45.0 mg/L. While nitrate itself is not typically harmful to humans at low levels, high concentrations of nitrate in drinking water can pose eutrophication, changes in aquatic plants and animals, and health risks, particularly to infants and pregnant women (Jorgensen *et al.*, 2014).

Conclusion

In this study, the physico-chemical parameters of fresh water can be varied in both the pre-monsoon and post-monsoon periods. As per the standard values of pH, temperature, electrical conductivity, total dissolved solids, dissolved oxygen, phosphate, and nitrate, changes in these parameters influence the decreasing quality of fresh water for the entire aquatic living biota as well as human usage. These changes occur due to high population, urban development and improper waste disposal of toxic effluents. These activities should be controlled and monitored periodically otherwise it may contaminate the water, which may result in unsuitable for drinking, agricultural and industrial purpose. This study may help us to regulate and screen the fresh water quality according seasonally.

The above study shows us the huge impact of Physico-chemical and Biological properties of fresh water sources due to seasonal variations and the abnormal growth of microorganisms which in turn affects the health of human beings, aquatic livestock's and habitats. These adverse effects will impact the long term survival and healthier environment adversely. We are in a critical stage of rectifying these impacts in an organized and scientific methods for a better aquatic environment which always have direct and indirect impacts on human beings and habitats.

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